



Projected Costs of U.S. Nuclear Forces, 2021 to 2030

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The Congressional Budget Office is required by law to project the 10-year costs of nuclear forces every two years. This report contains CBO's projections for the period from 2021 to 2030.

- If carried out, the plans for nuclear forces delineated in the Department of Defense's (DoD's) and the Department of Energy's (DOE's) fiscal year 2021 budget requests, submitted in February 2020, would cost a total of \$634 billion over the 2021–2030 period, for an average of just over \$60 billion a year, CBO estimates.
- Almost two-thirds of those costs would be incurred by DoD; its largest costs would be for ballistic missile submarines and intercontinental ballistic missiles. DOE's costs would be primarily for nuclear weapons laboratories and supporting activities.
- The current 10-year total is 28 percent higher than CBO's most recent previous estimate of the 10-year costs of nuclear forces, \$494 billion over the 2019–2028 period.
- Almost half (about 49 percent) of the \$140 billion increase in that total arises because the 10-year period covered by the current estimate begins and ends two years later than the period covered by the 2019 estimate. Thus, the period now includes two later (and more expensive) years of development in nuclear modernization programs. Also, costs in those two later years reflect 10 years of economywide

inflation relative to the two years that drop out of the 10-year projection; that factor (in the absence of other changes to programs) accounts for about one-fourth of the 49 percent increase.

- About 36 percent of the \$140 billion increase is projected to occur from 2021 to 2028—the years included in both this estimate and the 2019 estimate. That increase stems mainly from new plans for modernizing DOE's production facilities and from DoD's modernization programs moving more fully into production.¹

Background

Nuclear weapons have been an important component of U.S. national security since they were developed during World War II. During the Cold War, nuclear forces were central to U.S. defense policy, and a large arsenal was built. Since that time, nuclear forces have figured less prominently in defense policy than conventional forces have, and for many years the United States did not build new nuclear weapons or delivery systems, choosing instead to sustain or extend the life of existing ones.

The nation's current nuclear forces are reaching the end of their service life, and some delivery systems may not

1. The remaining 15 percent of the \$140 billion increase is in CBO's estimate of cost growth beyond budgeted amounts. The estimate of cost growth applies to the full 10-year period, and the difference between the current and previous estimates cannot reliably be divided into overlapping and nonoverlapping years.

Notes: Unless this report indicates otherwise, all of the years referred to are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.

Numbers in the text and tables may not add up to totals because of rounding.

"Cost" refers to budget authority, the amount that would need to be appropriated to implement the Department of Defense's and the Department of Energy's plans.

Supplemental data for this analysis are available on CBO's website (www.cbo.gov/publication/57130#data), as are previous editions of the report (<https://go.usa.gov/xHepK>).

be capable of having their service lives extended further. U.S. nuclear forces consist of submarines that launch ballistic missiles (SSBNs), land-based intercontinental ballistic missiles (ICBMs), long-range bomber aircraft, shorter-range tactical aircraft carrying bombs, and the nuclear warheads that those delivery systems carry. Over the next two decades, essentially all those systems will have to be refurbished or replaced with new systems if the United States is to continue fielding those capabilities.

Over the coming years, the Congress will need to make decisions about what nuclear forces the United States should field in the future and thus about the extent to which the nation will continue to modernize its nuclear forces. The Biden Administration is widely expected to undertake a nuclear posture review to determine the nuclear policies and forces it will pursue.²

To help the Congress make decisions about U.S. nuclear forces, the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112-239) required CBO to estimate the 10-year costs of operating, maintaining, and modernizing those forces. In response, CBO published *Projected Costs of U.S. Nuclear Forces, 2014 to 2023*.³ Then the National Defense Authorization Act for Fiscal Year 2015 (P.L. 113-291) required CBO to update that estimate every two years. This report is the fourth such update.⁴ In addition, in October 2017, CBO published an estimate of the 30-year costs of nuclear forces under existing plans and under various approaches for managing the costs of modernization.⁵

2. Beginning with the Clinton Administration, every Administration has undertaken and published a nuclear posture review, which summarizes policies about nuclear weapons and the forces needed to execute those policies.

3. See Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), www.cbo.gov/publication/44968.

4. The others are Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2019 to 2028* (January 2019), www.cbo.gov/publication/54914, *Projected Costs of U.S. Nuclear Forces, 2017 to 2026* (February 2017), www.cbo.gov/publication/52401, and *Projected Costs of U.S. Nuclear Forces, 2015 to 2024* (January 2015), www.cbo.gov/publication/49870.

5. See Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046* (October 2017), www.cbo.gov/publication/53211.

CBO's Projections of the Costs of U.S. Nuclear Forces Through 2030

Over the 2021–2030 period, the plans for nuclear forces specified in DoD's and DOE's 2021 budget requests, submitted to the Congress in February 2020, would cost a total of \$634 billion, CBO estimates (see Table 1).⁶ CBO projects that \$551 billion of that total would be needed to implement the plans as DoD and DOE have laid them out—provided those plans did not change or experience any cost growth or schedule delays. Those projections are not meant to predict DoD's and DOE's future budgets, because Administrations typically change plans from year to year. Rather, the projections extend the cost estimates that underlie the 2021 budget submissions under the assumption that there is no change in the planned size and composition of the nuclear forces or in the type, quantity, and schedule of weapons development programs.

The \$551 billion would fund the following items:

- **Strategic Nuclear Delivery Systems and Weapons (\$297 billion).** This category consists of DoD's funding for strategic nuclear delivery systems (the three types of systems that can deliver long-range nuclear weapons—SSBNs, ICBMs, and long-range bombers, often referred to collectively as the strategic nuclear triad), DOE's funding for activities related to the warheads used by those systems, and DOE's funding for the nuclear reactors that power SSBNs. Almost half of the costs in this category would be for ballistic missile submarines.
- **Tactical Nuclear Delivery Systems and Weapons (\$17 billion).** This category consists of DoD's funding for tactical aircraft that can deliver nuclear weapons over shorter ranges; DOE's funding for activities related to the warheads that those aircraft carry; funding for a new nuclear sea-launched cruise missile (SLCM); and funding for a warhead for that missile to carry.
- **DOE's Nuclear Weapons Laboratories and Their Supporting Activities (\$142 billion).** This category consists of funding for activities at nuclear weapons laboratories and production facilities that are not

6. CBO's estimates are based on the plans in the 2021 budget requests from DoD and DOE, not on appropriated amounts. Although the Congress has appropriated funds for 2021, not enough details are known about those appropriations and how the two departments have allocated them to formulate an estimate of the costs of nuclear forces that is directly comparable to the estimates in this report.

Table 1.

Projected Costs of Nuclear Forces, by Department and Function

Billions of Dollars

	2021			Total, 2021–2030		
	DoD	DOE	Total	DoD	DOE	Total
CBO's Projections of Budgeted Amounts for Nuclear Forces ^a						
Nuclear delivery systems and weapons						
Strategic nuclear delivery systems and weapons						
Ballistic missile submarines	9.2	1.0	10.2	130	15	145
Intercontinental ballistic missiles	4.2	0.7	4.9	70	12	82
Bombers	3.1	1.6	4.6	41	12	53
Other DoD nuclear activities ^b	1.4	n.a.	1.4	17	n.a.	17
Subtotal	17.9	3.3	21.1	259	39	297
Tactical nuclear delivery systems and weapons	0.4	0.5	0.8	9	8	17
Nuclear weapons laboratories and supporting activities						
Stockpile services	n.a.	0.9	0.9	n.a.	10	10
Facilities and infrastructure	n.a.	6.8	6.8	n.a.	80	80
Other stewardship and support activities ^c	n.a.	4.8	4.8	n.a.	52	52
Subtotal	n.a.	12.6	12.6	n.a.	142	142
Subtotal, Nuclear Delivery Systems and Weapons	18.3	16.3	34.6	268	189	456
Command, control, communications, and early-warning systems						
Command and control	1.4	n.a.	1.4	20	n.a.	20
Communications	1.7	n.a.	1.7	25	n.a.	25
Early warning	4.4	n.a.	4.4	49	n.a.	49
Subtotal, Command, Control, Communications, and Early-Warning Systems	7.5	n.a.	7.5	94	n.a.	94
Total Budgeted Amounts for Nuclear Forces	25.8	16.3	42.1	362	189	551
CBO's Estimates of Additional Costs Based on Historical Cost Growth	n.a.	n.a.	n.a.	43	40	83
Total Estimated Cost of Nuclear Forces	25.8	16.3	42.1	405	229	634

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/57130#data.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable.

- a. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, this category is based on CBO's analysis of DoD's and DOE's budget proposals and accompanying documents, as well as on CBO's projections of those budget figures beyond the next five years under the assumption that programs proceed as described in 2021 budget documentation. The category also includes several programs for which plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.
- b. This category includes nuclear-related research and operations support activities by DoD that CBO could not associate with a specific type of delivery system or weapon.
- c. This category includes security forces, transportation of nuclear materials and weapons, and scientific research and high-performance computing to improve understanding of nuclear explosions. This category also includes \$450 million in 2021 and \$5 billion over the 2021–2030 period for federal salaries and expenses.

attributable directly to a specific type of warhead but that are related to maintaining current and future stockpiles of nuclear weapons. Those activities include modernization of several facilities that produce specialized materials and components used in nuclear weapons.

- **DoD's Command, Control, Communications, and Early-Warning Systems (\$94 billion).** These systems allow operators to communicate with nuclear

forces, issue commands that control their use, detect incoming attacks, and rule out false alarms.

Annual budgets for all of those programs together would rise steadily from about \$42 billion to \$69 billion over the next decade, CBO estimates, increasing by roughly

60 percent between 2021 and 2030.⁷ About two-thirds of the costs would be incurred by DoD.

CBO projects that about \$188 billion of the \$551 billion total over the 2021–2030 period would go toward modernizing nuclear weapons and delivery systems.⁸ Of that amount, \$175 billion would go toward modernizing the strategic nuclear triad, and \$13 billion would be for modernizing tactical nuclear weapons and delivery systems.⁹ DoD’s programs for modernizing delivery systems would total about \$154 billion, and DOE’s programs for refurbishing warheads and developing a reactor for the new SSBN would total about \$35 billion. In addition to modernizing nuclear weapons and delivery systems, DOE’s plans include several projects to modernize facilities for producing materials and components used in nuclear weapons that are not included in the \$188 billion total; CBO estimates that those projects would cost about \$35 billion over the 2021–2030 period.

CBO’s estimates for *individual* programs reflect the assumption that DoD’s and DOE’s plans will be executed successfully and on budget. In other words, those estimates do not incorporate any cost growth beyond the funding levels planned by the two departments or any delays to program schedules. However, because programs often cost more than originally planned, CBO has incorporated cost growth into its *overall* estimate of the costs of nuclear forces. That growth amounts to \$83 billion (the difference between the \$551 billion cost for the plans as specified and the \$634 billion total cost). That amount represents CBO’s estimate of additional costs that would be incurred over the 2021–2030 period if the costs for nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past.

Nuclear forces account for roughly 7 percent of the total 10-year cost of the plans for national defense outlined

in the 2021 budget submission, CBO estimates.¹⁰ On an annual basis, that percentage is projected to rise from roughly 6 percent in 2021 to about 8.5 percent in 2030. Those values are about one percentage point higher than the ones that CBO estimated for the 2019–2028 period.

The development and procurement of nuclear weapons and delivery systems, driven by nuclear modernization programs, would constitute an increasing share of the Office of Management and Budget’s projection of DoD’s acquisition funding over the 2021–2030 period.¹¹ Many analysts have observed that competition for funding among acquisition programs will force difficult choices about which programs to pursue and could jeopardize nuclear or other high-priority programs.¹² For DoD’s programs, CBO projects that the costs of nuclear acquisition programs would represent more than 9 percent of DoD’s total planned acquisition costs over the next decade as outlined in the 2021 budget submission.¹³ That fraction would rise from about 6.5 percent in 2021 to more than 12 percent in 2030, CBO projects.

7. For more details about annual costs, see the supplemental data posted with this report on CBO’s website at www.cbo.gov/publication/57130#data.

8. The remaining \$362 billion of the \$551 billion total would fund operation, sustainment, and support activities for current and future nuclear forces.

9. For more details about modernization costs for the strategic nuclear triad by type of delivery system and by year, see the supplemental data included with this report on CBO’s website at www.cbo.gov/publication/57130#data.

10. That estimate is based on information in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2021: Analytical Perspectives* (February 2020), Table 24-1 (online only), <https://go.usa.gov/xHjzW> (PDF, 659 KB). Nuclear forces would account for a smaller percentage of total national security costs in the last few years of the projection period if, instead, CBO’s projection of DoD’s total budget was used in the calculation; see Congressional Budget Office, *Long-Term Implications of the 2021 Future Years Defense Program* (September 2020), www.cbo.gov/publication/56526.

11. Acquisition funding for DoD programs is the sum of the appropriations for procurement and for research, development, test, and evaluation. Planned DoD funding, by appropriation title, is available in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2021: Analytical Perspectives* (February 2020), Table 24-1 (online only), <https://go.usa.gov/xHjzW> (PDF, 659 KB).

12. See, for example, Rebecca Hersman and Joseph Rodgers, *Nuclear Modernization Under Competing Pressures* (Center for Strategic and International Studies, February 12, 2021), <https://tinyurl.com/ycph3vfy>.

13. That estimate is based on information in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2021: Analytical Perspectives*, (February 2020), Table 24-1 (online only), <https://go.usa.gov/xHjzW> (PDF, 659 KB). Acquisition costs for nuclear programs would account for a smaller percentage of total DoD acquisition costs in the last few years of the projection period if, instead, CBO’s projection of DoD’s acquisition costs was used in the calculation; see Congressional Budget Office, *Long-Term Implications of the 2021 Future Years Defense Program* (September 2020), www.cbo.gov/publication/56526.

Basis of CBO's Updated Estimates

CBO's estimate of total costs in this report consists of the costs of fielding, operating, maintaining, and modernizing U.S. nuclear forces. The agency prepared the report using the same approach that it used in its original 2013 report and subsequent updates, considering only costs that it identified as directly associated with the nuclear mission.¹⁴ Thus, CBO's estimate does not include costs indirectly associated with nuclear forces, which some other analyses include. As with all projections of future costs, CBO's estimates come with some uncertainty.

CBO's Approach to Estimating Costs

For this update, CBO analyzed DoD's and DOE's 2021 budget requests and their associated justification documents, which include budgeted amounts planned for the next five years. To produce 10-year estimates, CBO identified the budget lines for programs related to nuclear forces and extended them beyond the five-year period by examining the departments' long-range plans for each program. For some systems, like new ICBMs, air-launched nuclear cruise missiles, and new engines for the B-52 bomber, DoD has published estimates of the total program cost.¹⁵ For those systems, CBO projected costs beyond the five-year period in a manner consistent with those total cost estimates and DoD's planned production and fielding schedules.

For replacement systems that would be in development or initial production during the 2021–2030 period but that are not yet fully reflected in the departments' budgets, CBO estimated costs by reviewing the actual costs for analogous systems that have already been built and the schedules that would be necessary to meet production and fielding schedules consistent with the 2021 budget requests. In particular, CBO assumed that DoD would field a new SLCM as directed in the 2018 *Nuclear Posture Review* and that the design would draw from the development of a different missile—a new air-launched cruise missile called the Long-Range

Standoff Weapon and referred to as the LRSO—and its associated warhead.¹⁶ Specifically, CBO assumed that development costs for the SLCM would be half of the estimated total development costs of the LRSO and that the unit production costs of the two weapons would be the same. In the same way, CBO assumed that the SLCM's warhead would be similar to the LRSO's W80-4 warhead and projected that it would cost half as much to develop and have the same unit production costs. CBO's estimate of the costs of the SLCM and its warhead—about \$10 billion over the 2021–2030 period—is highly uncertain; in fact, it is still not clear whether the program will be pursued at all and, if so, what the design and development schedule will be. CBO did not include in its estimates any costs of integrating the SLCM onto submarines or surface ships; most of those costs would presumably occur after 2030.

To project personnel costs and the costs of operation and maintenance activities from 2026 to 2030, for most programs, CBO began with the levels of operation and maintenance activities and the number of military personnel planned for 2025 and projected that they would remain the same for the last five years of the period. CBO projects that the costs to maintain those same activities and personnel would grow slightly faster than inflation, a projection that is based on DoD's past experience. For some modernization programs that involve fielding new systems and retiring old ones, CBO used a model for operation and sustainment costs that incorporates the assumption that, for both the new and old systems, half of the costs would be fixed, and the remainder would be proportional to the number of each type of delivery system in the force.

To arrive at an estimate of overall cost growth, CBO used two different approaches. For some major modernization programs, the agency used the independent cost estimates that it developed as part of its 2017 estimate of the 30-year costs of nuclear forces (updated to address changes in programs when necessary) to estimate how much costs might rise above DoD's current projected budgets for those programs.¹⁷ For all other programs and activities, CBO estimated cost growth for each of the four categories of costs (research and development,

14. For more details about nuclear programs and CBO's approach to estimating costs, see Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), www.cbo.gov/publication/44968.

15. Bombers can be used both for nuclear and for conventional missions. In these 10-year estimates, CBO attributes 25 percent of the costs of the B-52 bomber and the new B-21 bomber to the nuclear mission and 75 percent to the conventional mission. Therefore, only 25 percent of the cost of replacing the engines on the B-52 is included in this estimate.

16. See Department of Defense, *Nuclear Posture Review* (February 2018), <https://go.usa.gov/xEng>.

17. For details about CBO's independent estimates, see Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046* (October 2017), Appendix A, www.cbo.gov/publication/53211.

procurement, military personnel, and operation and maintenance) as a whole, rather than program by program, on the basis of experience with DoD's and DOE's programs.¹⁸

Costs Not Included in CBO's Estimate

CBO's estimate does not include several categories of costs that are not directly related to developing and fielding nuclear forces over the next 10 years. For example, it does not include a prorated share of the military services' and DoD's overhead and support costs that are not specific to the nuclear mission—although such costs could change if DoD made significant changes in the size of its nuclear forces.

CBO's estimate also does not include the costs of several related activities—for example, the costs of addressing the nuclear legacy of the Cold War (such as dismantling retired nuclear weapons and cleaning up environmental contamination from past activities at nuclear facilities); the costs of reducing the threat from other countries' nuclear weapons (including U.S. efforts to halt proliferation, comply with arms control treaties, and verify other countries' compliance with treaties); and the costs of developing and maintaining active defenses against other countries' nuclear weapons (primarily ballistic missiles). CBO has not updated its estimates of any of the costs that are not directly related to nuclear forces, which were published in 2013, and such costs are not included in this report.¹⁹

Uncertainty in CBO's Estimates

CBO's estimates come with substantial uncertainty stemming mainly from two factors: Future plans are not yet fully determined for some programs; and estimates of the costs of developing, producing, and operating weapon systems are uncertain even when the plans are fully determined.

The indeterminacy of plans can lead to uncertainty in cost estimates in several ways. The largest source of uncertainty in the present 10-year estimate is attributable to unspecified production schedules for new

programs. Several major modernization programs are scheduled to move into full-scale production during the 2021–2030 period, and the number of systems that will be produced each year has not yet been included in budget documentation for some of those programs. DoD has begun to release Selected Acquisition Reports only for the Columbia class SSBN program. (Such reports contain planned production rates for the life of a given program.) For other programs whose plans are less well defined, CBO has used known milestones for fielding the systems and developed production rates that would reflect the minimum rates needed to reach those milestones. DoD could choose to use higher production rates, which would increase the time available to address potential delays. In that case, the total program production costs would not necessarily change, but the portion of those costs incurred within the 10-year period covered by this report could be higher.

There can also be uncertainty about the costs of operating new weapon systems as they are phased into the force. Toward the end of the current 10-year projection period, several modernization programs will begin to field new systems. For about a decade or more after those initial deployments, DoD will operate fleets comprising a mix of new and old systems. CBO has accounted for that by using a simple model for estimating operation and sustainment costs. The model incorporates the assumption that for each new system and each old system, costs would be half fixed and half proportional to the number of that type of delivery system in the force. Actual costs of operating and sustaining fleets comprising old and new systems may be higher or lower than CBO's estimates.

Changes in Estimated Costs

The estimate of \$634 billion in total costs for nuclear forces over the 2021–2030 period is \$140 billion, or 28 percent, more than CBO's January 2019 estimate of \$494 billion over the 2019–2028 period (see Table 2). The percentage increase for DOE is substantially higher than that for DoD: DOE's costs are projected to total \$229 billion, or 36 percent more than CBO estimated in 2019, whereas DoD's costs are projected to total \$406 billion, or 25 percent more than CBO estimated in 2019.

The largest contributions to the \$140 billion increase are higher costs for nuclear delivery systems and weapons, including costs for weapons laboratories and supporting activities. Projected costs for command, control, communications, and early-warning systems have also increased

18. For more details about CBO's approach to estimating cost growth, see Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), p. 18, www.cbo.gov/publication/44968.

19. CBO estimated the 10-year costs of missile defense as part of the following report: Congressional Budget Office, *Costs of Implementing Recommendations of the 2019 Missile Defense Review* (January 2021), www.cbo.gov/publication/56949.

Table 2.

Differences in 10-Year Costs Between CBO’s Current and Previous Projections of the Costs of Nuclear Forces

Billions of Dollars

	10-Year Costs		
	DoD	DOE	Total
CBO’s Previous Projection for 2019 to 2028			
Total Estimated Costs, 2019 to 2028	326	168	494
Difference in 10-Year Total (Current projection minus previous projection)^a			
CBO’s Projections of Budgeted Amounts for Nuclear Forces^b			
Nuclear delivery systems and weapons			
Ballistic missile submarines	34	4	38
Intercontinental ballistic missiles	14	7	21
Bombers	3	1	4
Other DoD strategic nuclear activities ^c	1	n.a.	1
Tactical nuclear delivery systems and weapons	2	*	2
Nuclear weapons laboratories and supporting activities	n.a.	36	36
Command, control, communications, and early-warning systems	17	n.a.	17
Subtotal, CBO’s Projections of Budgeted Amounts for Nuclear Forces	71	48	119
CBO’s Estimates of Additional Costs Based on Historical Cost Growth	8	13	21
Total Difference	79	61	140
CBO’s Current Projection for 2021 to 2030			
Total Estimated Costs, 2021 to 2030	405	229	634

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/57130#data.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable; * = less than \$500 million.

- a. A positive amount indicates that the current projection is greater than the previous one, which was published in Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2019 to 2028* (January 2019), www.cbo.gov/publication/54914.
- b. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, this category is based on CBO’s analysis of DoD’s and DOE’s budget proposals and accompanying documents, as well as on CBO’s projections of those budget figures beyond the next five years under the assumption that programs proceed as described in budget documentation. The category also includes several programs for which plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.
- c. This category includes nuclear-related research and operations support activities by DoD that CBO could not associate with a specific type of delivery system or weapon.

substantially. Moreover, CBO’s projection of cost growth over 10 years is also substantially higher than it was in 2019.

The higher estimates in this report do not necessarily signal an increase in programs’ total lifetime costs. For example, about 49 percent (or \$68 billion) of the difference between CBO’s current and 2019 estimates is attributable to the fact that the current projections cover a 10-year period that starts and ends two years later than the period covered by the 2019 estimate. (In the previous report, estimated costs in 2019 and 2020 totaled \$67 billion; those years drop out in this report, and estimated

costs in the added years of 2029 and 2030 total \$136 billion.) Thus, in the current estimate, new programs are two years further along in the process of ramping up development, and some are entering or are further along in the production phase—both of which tend to be characterized by higher annual costs. Also, costs in those two later years reflect 10 years of economywide inflation relative to the two years that drop out of the 10-year projection; that factor (in the absence of other changes to programs) accounts for about one-fourth of the \$68 billion increase.



An additional 36 percent (about \$50 billion) of the difference between CBO's current and previous projections involves the eight years in which the projections overlap (see Box 1). Costs in those years are now projected to be about 14 percent higher than CBO previously projected. Differences in estimates for those years stem from a number of factors:

- Most of the increase during the years of overlap is for DOE. The majority of that increase comes from new plans for modernizing production facilities for strategic materials like lithium, tritium, and enriched uranium. Other increases are related to warhead life-extension programs for which funding schedules have been accelerated relative to the schedules in the 2019 estimate.
- The largest increase for DoD during the years of overlap is in the SSBN category. The largest contribution in that category comes from higher planned funding for operating the current generation of SSBNs in the 2021 budget submission than was requested in the 2019 budget, consistent with the Navy's new plans to operate some of those submarines longer than previously planned.²⁰
- The next largest increase for DoD during the years of overlap is in the command, control, communications, and early-warning category. That increase is mainly attributable to the fact that requested funding for DoD's next-generation missile warning satellites is substantially higher in the 2021 budget submission than in the 2019 budget.

The remaining 15 percent (about \$21 billion) of the \$140 billion increase occurs in CBO's estimate of cost growth beyond budgeted amounts. The estimate of cost growth applies to the full 10-year projection period, and the difference between the current and previous estimates cannot reliably be divided into overlapping and nonoverlapping years.

Nuclear Delivery Systems and Weapons

By CBO's estimate, the amounts needed to implement the plans for nuclear systems and weapons as DoD and DOE have laid them out in their 2021 budget

submissions (provided those plans did not change or experience any cost growth or schedule delays) would total \$456 billion over the 2021–2030 period, \$102 billion more than the \$355 billion that CBO estimated in 2019 for the 2019–2028 period. The two primary reasons for that increase are: Some major modernization programs are completing development and moving into full-rate production; and additional modernization efforts have been planned, particularly by DOE. In addition, plans for some programs have become clearer or have changed since the departments' budget requests for 2019.

Ballistic Missile Submarines. Budgeted amounts for SSBNs would total \$145 billion over 10 years, CBO projects. That total is about \$38 billion more than the 2019 estimate (see Table 2 on page 7). Most of that amount would be for DoD's SSBN-related programs, which are projected to cost \$130 billion over the next decade, about \$34 billion more than CBO's 2019 estimate.

Most of the increase results from the fact that the current estimate extends through 2030 rather than 2028. Under the plans in DoD's 2021 budget request, the program for developing a new SSBN will have completed the design phase and will have passed the halfway point of procurement by 2030. In that year, the seventh new submarine (of 12 total) is expected to be authorized, and the six submarines that had been authorized previously would have either been built or would still be under construction. The program would then be entering a plateau in the construction effort that extends for nearly a decade after 2030; whereas authorization of the first two submarines would occur over a period of five years (with no new authorizations in three of those years), plans call for a new one to be authorized every year from 2026 through 2035. Other contributors to the increase include the following:

- The effort to extend the life of the D5 SLBM to allow that missile to be used throughout the lifetime of the Columbia class will be ramping up;
- Operation costs for the Ohio class submarines are higher in the 2021 budget submission than they were in the 2019 budget, and CBO has extended those trends in its projections consistent with plans to operate some Ohio class submarines longer than had previously been planned;

20. For information on the number of Ohio class SSBNs operating, see Ronald O'Rourke, *Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress*, Report for Congress R41129, version 202 (Congressional Research Service, February 19, 2021), p. 7, <https://go.usa.gov/xHDQw>.

Box 1.

Differences Between CBO’s Current and Previous Estimates During Years of Overlap

One of the goals of updating this report every two years is to assess the budgetary effects of changes in plans for nuclear forces, or in the execution of those plans, since the previous report was published. The most direct way to do that is to compare estimates only during the years in which they overlap, in this case 2021 through 2028 (see the table). That approach highlights those differences between estimates that are the result of changes in plans by largely removing the effects of the natural ramp-up of activity typical of weapons development programs and the effects of economywide inflation in prices.

The cost categories with the largest differences in projected budgets (provided plans did not change and that programs did not experience cost growth or schedule delays) during the overlapping years are nuclear weapons laboratories and supporting activities (a \$23 billion, or 23 percent, increase) and submarines that launch ballistic missiles (a \$15 billion, or 17 percent, increase). To a lesser degree, there are increases in the command, control, communications, and early-warning systems and land-based intercontinental ballistic missiles categories. The programmatic changes that led to those increases in the Congressional Budget Office’s estimates are described in this report.

Differences in 8-Year Costs Between CBO’s Current and Previous Projections of the Costs of Nuclear Forces (During the overlapping years, 2021–2028)

Billions of Dollars	8-Year Costs		
	DoD	DOE	Total
CBO’s Previous Projection for 2021 to 2028			
Total Estimated Costs, 2021 to 2028 ^a	248	116	364
Difference in 8-Year Total (Current projection minus previous projection)^b			
CBO’s Projections of Budgeted Amounts for Nuclear Forces ^c			
Nuclear delivery systems and weapons			
Ballistic missile submarines	13	2	15
Intercontinental ballistic missiles	1	4	5
Bombers	0	2	2
Other DoD strategic nuclear activities ^d	0	n.a.	0
Tactical nuclear delivery systems and weapons	0	-1	-1
Nuclear weapons laboratories and supporting activities	n.a.	23	23
Command, control, communications, and early-warning systems	6	n.a.	6
Total Difference	20	30	50
CBO’s Current Projection for 2021 to 2028			
Total Estimated Costs, 2021 to 2028 ^a	268	147	415

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/57130#data.

This table does not include CBO’s estimate of cost growth beyond budgeted amounts. The estimate of cost growth applies to the full 10-year period, and the difference between the current and previous estimates cannot reliably be divided into the overlapping and nonoverlapping years.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable.

- a. Total does not include additional costs based on historical cost growth.
- b. A positive amount indicates that the current projection is greater than the previous one, which was published in Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2019 to 2028* (January 2019), www.cbo.gov/publication/54914.
- c. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, this category is based on CBO’s analysis of DoD’s and DOE’s budget proposals and accompanying documents, as well as on CBO’s projections of those budget figures beyond the next five years under the assumption that programs proceed as described in budget documentation. The category also includes several programs for which plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.
- d. This category includes nuclear-related research and operations support activities by DoD that CBO could not associate with a specific type of delivery system or weapon.



- Operation and sustainment costs will begin for the Columbia class SSBN as the first submarine prepares for its initial deployment in 2031; and
- DoD's approach to distributing funding for Columbia class submarines differs from that used by CBO in the 2019 estimate; that difference, which involves the annual allocation of costs, does not change the total cost of the program, but it does change the annual costs incurred during the 2021–2030 projection period.

DOE's share of the amounts budgeted for SSBNs would be \$15 billion over 10 years, CBO projects, \$3 billion more than the 2019 estimate. That increase is related to changes in warhead life-extension programs. Two new warhead programs for SSBNs, the W93 and the Future Strategic Missile–Sea-Based Warhead, have replaced the Interoperable Warhead programs, which would have been shared between SSBNs and ICBMs. The costs of those new programs are higher during the 10-year projection period than the costs of the programs they replaced.

Intercontinental Ballistic Missiles. The amounts budgeted for ICBMs would total \$82 billion over 10 years, CBO projects, about \$70 billion for DoD and about \$12 billion for DOE. That total is about \$21 billion more than the 2019 estimate, an increase mostly attributable to the different time period covered by that estimate.

Most of the estimated \$14 billion increase in DoD's share of the costs results from a ramp-up in the costs of development and early production of a new ICBM, the missile portion of the Ground Based Strategic Deterrent program. When making this estimate, CBO assumed that production would begin in 2026 and continue into the 2030s. Similarly, the ramp-up of an effort to refurbish the ICBM silos and communications infrastructure has contributed to an increase in DoD's projected ICBM costs, as have ramp-ups in the program to develop and produce a new reentry vehicle to carry the nuclear warhead and to procure new helicopters that transport maintenance and security personnel on ICBM bases. For all the programs, the increases in estimated costs are mostly the result of the current estimate starting and ending two years later than the period used for the 2019 estimate.

DOE's ICBM costs are projected to be about \$7 billion higher over the next 10 years than CBO estimated in 2019. Like the SSBN warhead programs, ICBMs have new warhead life-extension programs that replace the

Interoperable Warhead programs. The new programs, the W87-1 and the Future Strategic Missile–Land-Based Warhead, have higher costs during the 10-year period than the programs they replace.

Bombers. Under the plans in the departments' 2021 budget request, the amounts budgeted for the bomber portion of nuclear forces would total \$53 billion over the 2021–2030 period, CBO projects, about \$4 billion more than CBO's 2019 estimate for the 2019–2028 period. Of that total, \$41 billion would go to DoD (\$3 billion more than CBO estimated in 2019), and \$12 billion would go to DOE (\$1 billion more than CBO estimated in 2019).²¹

The increase in DoD's costs is almost entirely the result of two more years of production for the B-21 bomber than the 2019 estimate included (initial deliveries to the Air Force are slated to begin in the mid-2020s). On the DOE side, most of the increase in costs is for extending the life of the W80-4 warhead, both because that effort is now two years further along and because DOE has increased its estimate of the program's overall cost. That increase is partially offset by a decrease in the projected cost of B61-12 life-extension program, which is slated to be complete around 2026.

Other DoD Nuclear Activities. This category, which consists of DoD's support activities for strategic nuclear forces that CBO could not associate with a particular weapon system, would cost a total of \$17 billion over 10 years, about \$1 billion more than CBO's 2019 estimate. That increase is mostly for administrative support for the Air Force's acquisition of nuclear systems.

Tactical Nuclear Delivery Systems and Weapons. CBO estimates that tactical nuclear capability would cost \$17 billion over the next 10 years, about \$2 billion more than CBO's 2019 estimate. Almost all of that increase is for DoD and pertains to CBO's estimate of the cost of the new sea-launched cruise missile, which was called for in the 2018 *Nuclear Posture Review*. The current estimate

21. Bombers can be used both for nuclear and for conventional missions. In these 10-year cost estimates, CBO attributes 25 percent of the costs of the B-52 bomber and the new B-21 bomber to the nuclear mission and 75 percent to the conventional mission. For the B-2 bomber and nuclear-capable cruise missiles, by contrast, CBO attributes all costs to nuclear missions. If the full costs of B-52 and B-21 bombers were included, the total costs of nuclear forces, with cost growth, would be \$711 billion.

accounts for two more years of development of that missile than the 2019 estimate did.

The estimated cost for DOE to produce the warhead for the SLCM also increases because of those two additional years of development in the current estimate. However, that increase is largely offset by a decrease in the 10-year costs of the B61-12 Life Extension Program (which would be carried for tactical missions by the F-35 aircraft), which is slated for completion around 2026. The technical specifications of the SLCM and its warhead, and whether it would be carried on surface ships, submarines, or both, are under review by DoD. For the purpose of this estimate, CBO assumed that the design of the SLCM and its warhead would be adapted from ongoing development of the LRSO.

Nuclear Weapons Laboratories and Supporting Activities. The amounts that DOE budgets for its nuclear weapons laboratories and supporting activities would total \$142 billion over the 2021–2030 period, CBO projects, \$36 billion more than the 2019 estimate spanning the 2019–2028 period.²² Roughly one-third of that increase stems from the different time periods covered by the two estimates.

Many DOE activities have higher planned budgets than in the 2019 estimate; however, the DOE budget was restructured for the 2021 submission, which complicates the task of tracking changes in the costs of activities from previous amounts through the full five years described in the budget submission. The new budget structure is intended to improve program execution by grouping activities according to how they are managed. One area of particular emphasis, for both new programs and existing ones, is modernization of production facilities, which comprises the following:

- Primary capability modernization, which improves facilities associated with plutonium, plutonium pit manufacture, and high explosives;

- Secondary capability modernization, which improves facilities to process and fabricate weapons components using uranium and lithium;
- Tritium modernization and domestic uranium enrichment, which improves facilities to produce and process tritium and enriched uranium; and
- Nonnuclear capability modernization, which improves facilities to design and produce nonnuclear components, such as radiation-hardened electronics.

Command, Control, Communications, and Early-Warning Systems

The amounts that DoD budgets for nuclear command, control, communications, and early-warning systems would total \$94 billion over 10 years, CBO projects, about \$17 billion more than the 2019 estimate. That increase is driven largely by changes in DoD's plans for early-warning satellites (which detect missile launches by adversaries) to replace the Space-Based Infrared System with the Next-Generation Overhead Persistent Infrared system, along with a new ground system for communicating with the satellites.²³

Additional Costs Based on Historical Cost Growth

Weapons programs frequently cost more than originally budgeted. If nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past, they would cost an additional \$83 billion over the next 10 years, \$21 billion more than the cost growth CBO estimated in 2019. Nearly all of that increase is in DOE's share of the costs of nuclear forces, mainly because DOE's plans include increased efforts to extend the service lives of warheads and to build new facilities. Historically, those types of efforts have been particularly susceptible to cost growth.

22. That total does not include funding for sustaining and modernizing specific nuclear warhead. Those amounts are grouped with the delivery systems that carry them.

23. See Lee Hudson, "U.S. Space Force Juggles Changes to Missile Warning Portfolio," *Aviation Week* (March 19, 2021), <https://tinyurl.com/j5uzftfp>.

This Congressional Budget Office report was prepared in response to a requirement in the National Defense Authorization Act for Fiscal Year 2015. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

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CBO continually seeks feedback to make its work as useful as possible. Please send any comments to communications@cbo.gov.



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